http://www.ftsm.ukm.my/apjitm
Asia-Pacific Journal of Information Technology and Multimedia
Jurnal Teknologi Maklumat dan Multimedia Asia-Pasifik
Vol. 6 No. 2, December 2017: 31 - 42
e-ISSN: 2289-2192

SUCCESS FACTORS AFFECTING THE HEALTHCARE PROFESSIONALS TO UTILIZE CLOUD COMPUTING SERVICES

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ABSTRACT

Integrating the new technologies to improve the healthcare services can be seen as one of the research trends nowadays, as earlier studies have recommended the potential of emerging technologies in enhancing healthcare service practices by means of providing more opportunities to carry out activities essential for prevention, diagnosis, monitoring, and treatment of the disease. Involving the cloud computing services in healthcare domain can offer a way for handling and maintaining health data by making use of software applications hosted on the Internet. To ensure successful cloud computing utilization, a pre-examination on the context of usage should be applied in order to collect the real needs to guarantee getting all the possible benefits of this technology. In Iraq, the health records of public hospitals consist of various types of data which continue to increase in velocity, volume, and variety progressively. This has led to several major issues to the health sectors from two perspectives, data complexity and low IT integrity. For that reason, managing and maintaining all these health data are essential to healthcare organizations. In this paper, we collected the success factors that may influence the healthcare professionals to utilize cloud computing services for the health sector in Iraq. This is done by conducting an interview with 30 physicians and technicians from four hospitals in Iraq, then a literature survey was carried out to verify that all the gathered factors are within the circumstance of healthcare. It has been found that eight factors may affect the perspective of healthcare professionals to utilize cloud computing services. Finally, a conceptual model was developed based on the findings.

Keywords: e-health, Health Informatics, Health Information System, Cloud Computing, Cloud Health Information System (CHIS), Success determinants, and Model.

INTRODUCTION

The health information systems usually used in health sectors to allow the healthcare professionals to manage and monitor patients' health records as well as transferring the information related to the hospitals. In addition, the function of health services is to support public requirements which include certain guidelines with regards to food, drugs and safety policies in order to sustain a healthful environment in various geographical regions. It is evident from the literature that previous studies have advised the use of new trend technologies to improve the offered healthcare services (Dixon *et al.* 2009). Therefore, the Information Technology (IT) considered as one of the most important aspects that must be taking into consideration in order to utilize the new technologies for the healthcare organizations to be able to access and process a big amount of patient's records together with protecting these records and supplying enough storage spaces (Barbarito *et al.* 2012). The speeding up innovations involving cloud services has led to numerous implications in healthcare distribution. There are several difficulties still facing the most recent electronic health systems in terms of client assistant, cost, tragedy recovery and online connectivity (Kasthurirathne *et al.* 2015). Thus, the cloud applications in this context can provide a remarkable benefit to the healthcare field. The cloud services can be defined as the services that can be applied in any domain such as

healthcare domain to allow them to handle and process health data in a distributed health environment (Sultan 2014). Furthermore, the cloud computing includes shared computing solutions that can be reached by using the Internet (Oliveira *et al.* 2014). Additionally, it delivers various features like self-service, resource pooling, rapid elasticity, ubiquitous network access, and pay-per-use pattern. Moreover, it offers several kinds of services which can be classified into SaaS (Software as a Service), PaaS (Platform as a Service) and IaaS (Infrastructure as a Service) as shown in Figure 1, these services are handled by several types of cloud deployment models such as public, private, hybrid and community clouds (Kadhum and Hasan 2017).

With all the remarkable benefits which can cloud computing provided to the healthcare sector, there seems that there is a limited understanding regarding the low utilization of these types of services in developing countries (Ahuja *et al.* 2012). From the literature, it can be observed that the majority of studies about cloud computing within organizations give attention to the SaaS applications which offered to private and public healthcare sectors. PaaS services are much more related to the engineering of the software program to operate these services. IaaS is associated with the platform infrastructure visualization. Since this study is much more concern about the cloud computing services that can be offered to the Iraqi public healthcare sector, SaaS start to be identified in this environment by which it is implemented depending on service deployment models.

BACKGROUND

Limited utilization of patient's information throughout decision making, as well as ineffective communication amongst patient care associates, resulted in the occurrence of severe medical mistakes which in turn decrease the level of quality of the healthcare services, in developing countries particularly (Griebel *et al.* 2015). In Iraq, its critical to decision makers for deciding the effectiveness of technologies used in the health sectors. This is because of the insufficient evidence regarding the IT integrity in the healthcare sector (Akunjee and Ali 2002). Some attempts are already taken by the Iraqi ministry of health in order to deploy some cloud models to be able to promote health-related practices in various sectors. This includes re-engineering the data storing method of patients and other health-related information, and thus let healthcare professionals to efficiently access and interpret the conditions of the patients (Zeber *et al.* 2010). In spite of these concerns, there will be some obstacles in determining the current requirements of healthcare sectors to be able to accommodate technologies for example distributed and grid computing (Hameed *et al.* 2015). Insufficient understanding of the health care status to deploy most of these technologies would make it hard to handle the new healthcare systems utilization in terms of scaling, dynamicity, and low cost. In addition, the Iraqi current situation makes it much more challenging to adopt specific technology without having pre-examination on its suitability within the context of utilization. Moreover, the healthcare data of the Iraqi public hospitals consist of different kinds of data which continue increasing in volume, velocity, and variety progressively. This has led to some main issues to the Iraqi public healthcare sectors from 2 perspectives, low IT integrity and data complexity (Meri et al., in-press). As a result, controlling and maintaining all these health records tend to be essential for healthcare organizations. So, cloud computing could be utilized as a way to deliver a reliable service for managing and maintaining healthcare records. The reason why this study focused on the cloud services application is that of the high cost of the software, complexity, and inflexibility problems of traditional EHR (Electronic Healthcare Records). Therefore, these play a key role in raising the need for utilizing inexpensive service that provides the healthcare sectors a flexible solution for managing and maintaining health data remotely. Also, the Iraqi public healthcare sectors are based mostly on their computing

infrastructure. Therefore, the data still exists on premises thus makes it all under human and environmental threats altogether. Based on this, Al Hilfi et al. (2013) mentioned that "Efforts are needed to reinforce the quality of information as it goes up the chain coming from facility to the ministry of health" Thus, this study tries to explore the major determinants for utilizing cloud computing services in the Iraqi public healthcare sectors.

RESEARCH METHOD

In this paper, a preliminary study was conducted in four Iraqi hospitals to collect the main antecedents that may affect the healthcare workers to utilize cloud computing technology services for their health information systems. Also, a literature survey was carried out in order to gather related information regarding the gathered factors and to verify that these factors being used in other studies in the context of healthcare.

For the preliminary study, a qualitative research design had been selected to gather information within a social context which is focused on the way persons interpret and make sense of their experience (Ritchie *et al.* 2013). In order to deeply investigate a phenomenon within a real-life context, a case study research was adapted (Yin 2013). An Interview technique has been used by applying semi-structured form and 14 open-ended questions were asked in this interview, this is because these types of questions allow the respondents to give a deep information about the situation (Jacob and Furgerson 2012). A total of 15 physicians and 15 technicians that aware about cloud services were interviewed. The target population was selected from four main hospitals located in Baghdad, Iraq. The reason behind choosing these hospitals back to its capacity and capability in offering health aids as well as these hospitals are the main hospitals that using the IT facilities to offer their services. Content analysis method has been used in order to analyze qualitative data in a thematic way, as it considered as a systematic technique for compressing many words of text into fewer content categories based on explicit rules of coding (Stemler 2003). As for the demographic background of the participants, it has been identified that four females and 26 males that aged 26-44 years old and have about 2-3 years of experience using cloud health information system.

SUCCESS DETERMINANTS

1. **Cost effectiveness**: Is the assessment for emerging new technologies, on a one-by-one basis (Jena *et al.* 2009). The interviewees declared that one of the main antecedents in utilizing any technology is the cost, which can affect the decision makers' perception to consider utilizing it. One of the physicians asserted that "I do not see the sense of having the ministry planning to spend on technology utilization in healthcare without studying what is needed which may reduce the cost to be spent on such utilization". On the other hand, the literature shows that this factor has been raised as an important factor in studies about technology adoption (Laupacis *et al.* 1992, Bardhan and Thouin 2013, Jiang *et al.* 2013). The utilization of new technologies might be costly for organizations (Philipson and Jena 2013), so that, it is estimated that inexpensive cloud-based system will positively affect the healthcare worker' perception towards utilizing it.
2. **Hardware Modularity:** The interview revealed that there are several limitations of the available hardware recourses to generalize the use of health information systems. In addition, the interviewees asserted that control the process associated with the utilization of cloud services within the Iraqi context was identified as the main cause for not taking into consideration such utilization, which has been reasoned to a number of organizational factors, like for example, the lack of existing infrastructure to provide required tools to run such systems (Meri et al., in-press). Previous studies frequently described that factor as an

organizational element which can affect environment adoption as well as the use of technology (Berg 2001, Chiasson *et al.* 2007, Sockolow *et al.* 2015). Making sure of sufficient hardware modularity within an organization is believed to enhance the scalability of healthcare applications by embedding mandatory devices to develop and also debug different health-related issues from one department to multiple ones (Elhadi and Sharif 2014). Therefore, providing healthcare workers with the adequate hardware equipment might significantly lead to raising their confirmation of its effectiveness to manage and communicate healthcare data throughout departments (Halilovic and Cicic 2013). Thus, ensuring that the existing hardware can be utilized in cloud environments might impact the health care worker's perception towards utilizing the services of cloud computing in their hospitals.

3. **Software Modularity:** The process associated with executing several tasks in a system can be somehow related to the modularity for the design associated with the process development as well as comprehensibility (Gershenson *et al.* 2003). Interviewees asserted on the effectiveness of considering this factor when it comes to adopting cloud technology, in which being sure that the existing platforms can easily handle the cloud application could possibly increase the approval of the healthcare workers to utilize cloud-based services. The literature revealed that the majority of the scholars agreed that the software modularity play as an essential factor in any new technology usage and adoption (Heeks 2006, Gaynor *et al.* 2014). Sant'Anna et al. (2007) viewed the significance of taking into consideration software modularity factor to allow persons to operate and use of technology. Meanwhile, Sun et al. (2015) reported that having up to date software can assist the organization in order to maintain appropriate technology utilization depending on the flexibility of its IT infrastructure that conforming to the method that applications could be reconfigured with minimum efforts. Therefore, this factor considered very importantly to influence the individuals to utilize the new technology.
4. **Internet Network:** The interview respondents described the lack of Internet network connectivity as one of the main antecedents that limit their use of the new technologies. At the same time, a number of scholars declared that there are some difficulties facing the developing countries in regards to the Internet, based on Lawrence & Tar (2010), these challenges are caused by the bad telecommunication capabilities as well as the erratic supply of the power. Network in this research is the telecommunication infrastructures necessary to connect several healthcare sectors and users within just a state or even the nation. However, the healthcare workers are still facing some difficulties in communicating and sharing health-related data across departments, this is due to the limited accessibility to the sufficient basic infrastructure Aziz et al. (2009). This, as a result, led the researcher in the present work to take into account the purpose of Internet network factor in driving healthcare workers to utilize the cloud health information systems. Additionally, It is evident from the literature that network quality is one of the important factors influencing a new technology adoption (Schultze and Wanda 2004, Panda and Rath 2016). Simultaneously, Hall & Robert (1987) stated that the organization needs to take into account the network quality whenever it needs to adopt computer network. This is also supported by Steinbart & Nath (1992) who proposed that the computer network is an important aspect that drives an organization management. Based on Chih-Chien et al. (2005), network factor may positively affect users' utilization experience due to its role to shape IT use decisions. Therefore, considering this factor when adopting cloud services is a must be in a developing countries context.
5. **Training Availability:** Training is the accessible resources that organizations offer for workers in order to achieve the expertise needed to operate and utilize technology (Petersone *et al.* 2016). The interviewees assist on the availability of training to make them more confident when using the cloud technology in their systems as understanding all the

capabilities of the offered technology might influence them to accept it more. Also, they stated that there are not enough training programs provided for them in a timely manner. Previous studies frequently highlighted the importance of training and the available resources in building individual's decision to utilize technology services (Mantovani *et al.* 2003, Eley *et al.* 2008, Najaftorkaman *et al.* 2015). Chau & Hu (2002) reported the significance of delivering the resources (which includes training) to take advantage of telemedicine technologies in patient care and management. Furthermore, Lee (2010) stated that the lack of training resources (including lack of the technical training & support) within an organization would badly impact users' confirmation with their personal technological expectations. This result led the researcher to consider the role of this factor to utilize cloud services in the health sector based on the needs declared by the health workers as well as the literature recommendations.

6. **System Compatibility:** In order to obtain richer insights in to the main factors that might influence the SaaS utilization, the researcher tried to get deep answers in the interview, in which the interviewees have shown several concerns regarding the compatibility of the current cloud services in order to process healthcare records and their appropriateness to provide the services for these components. Rogers (2004) explained that system compatibility as how the existing system matches with the individual's existing values, previous practices, and current needs. It is assumed when the healthcare workers realize that the Cloud Health Information System (CHIS) is compatible with their work practices or style, they will positively utilize it. However, the compatibility of a system as a key facilitator was not adequately examined in the Iraqi healthcare organizations. Based on that, the researcher will examine this factor in the Iraqi health sector organizations, as the literature showed that compatibility is a necessary aspect that must be taken into consideration when studying new technology adoption (Roberts and Wilson 2002, Wu *et al.* 2013). Jen-Her Wu et al. (2007) reported that the compatibility of cloud health information system (CHIS) significantly affect the acceptance perception of the healthcare professionals to make use of it.
7. **System Complexity:** Oliveira et al. (2014) defined the complexity of the system as the level to which new technology is actually perceived to become relatively complicated to understand as well as use. It is evident from the literature that making use of cloud-based services in healthcare domain might results in some challenges for all those lacking in technological expertise & IT specialists (Ifinedo 2011, Thiesse *et al.* 2011). These concerns were also declared by the interviewees, as they highlighted the importance of easy to use systems that can be used by all the health workers especially those who have a simple knowledge and experience using the IT systems and technology. According to Nor & Pearson (2015), the system complexity is associated mostly with how individuals perceive technology to become relevant to the self-experience. Also, it is correlated along with users' mental attempts necessary to use the system. This, in turn, might positively impact users' control over tasks and actions whenever processing medical-related data. As such, system complexity can be considered as the key criterion when making the decision to utilize cloud health information systems.
8. **Data Security and Privacy:** A security threats can be identified as an organization might experience loss in person's information, private records, or some other sensitive data (Zhou *et al.* 2010a, Milutinovic and De Decker 2016). The interviewees acknowledged that the security and privacy is one of the main antecedents that limited their usage of cloud-based systems, some of them perceived that the existing health care systems do not guarantee the privacy as well as security of the health-related records due to the fact that all of these systems deal with simple authentication, and also the current system doesn't provide enough functionalities to ensure records' safety. The literature shows the importance of security and

privacy of data in cloud environment, as it discussed recently in many studies (Duquenoy *et al.* 2013, Li *et al.* 2013, Sahama *et al.* 2013, Kalogridis and Dave 2014, Alboaie *et al.* 2015, Najaftorkaman *et al.* 2015, Shrestha *et al.* 2016). Lallmahamood (2015) described security as the threat which may result in damage to network, resources or data. This can be caused by outsiders or even insiders when accessing the internal network (Lake *et al.* 2014, Bellekens *et al.* 2016). In many developing countries, security issues are always rated high (Thulani *et al.* 2015). Soceanu et al. (2015) mentioned that the privacy of healthcare data may efficiently effect the way health care professionals understand the system to become sufficient as well as usable for very sensitive medical cases. Therefore, earlier studies suggested examining the concerns of the privacy and security of the data when planning technology utilization in healthcare settings (Sahi *et al.* 2016).

Table 1 shows a collection of previous studies that have been conducted in different healthcare and non-healthcare contexts. It is also noted that most factors which were identified in the preliminary phase were supported. From the literature, it is evident that all mentioned factors are relevant to the context of this study.

TABLE 1. Previous works related to the present study's factors

Factor	References
Cost effectiveness	(Jena *et al.* 2009), (Laupacis *et al.* 1992), (Philipson and Jena 2013), (Bardhan and Thouin 2013), (Jiang *et al.* 2013), (Coppit and Sullivan 2003), (Motz *et al.* 2006), (Wang *et al.* 2009)
Hardware modularity	(Byrd and Douglas 2001), (Chiasson *et al.* 2007), (Sockolow *et al.* 2015), (Elhadi and Sharif 2014), (Panda and Rath 2016), (Berg 2001), (Halilovic and Cicic 2013)
Software modularity	(Sant'Anna *et al.* 2007), (Schaarschmidt *et al.* 2013), (Saxena *et al.* 2017), (Gaynor *et al.* 2014), (Heeks 2006), (Gershenson *et al.* 2003), (Melton and Tempero 2007), (Conley and Sproull 2009), (Sun *et al.* 2015), (Green *et al.* 2004)
Internet Network	(Panda and Rath 2016), (Schultze and Wanda 2004), (Hall and Robert 1987), (Steinbart and Nath 1992), (Lawrence and Tar 2010), (Chih-Chien *et al.* 2005)
Training availability	(Petersone *et al.* 2016), (Venkatesh & Speier, 2000), (Najaftorkaman *et al.* 2015), (Ibrahim and Perez 2014), (Chopra *et al.* 2014), (Maditinos *et al.* 2014), (Eley *et al.* 2008), (Ackerman *et al.* 2010), (Chau & Hu, 2002), (Bello *et al.* 2004), (Alinier *et al.* 2004), (Lee 2010)
System compatibility	(Rogers 2004), (Roberts & Wilson, 2002), (Wu *et al.* 2013), (Wu *et al.* 2007), (Hung *et al.* 2014)
System complexity	(Oliveira *et al.* 2014), (Ifinedo 2011), (Thiesse *et al.* 2011), (Nor and Pearson 2015), (Nwankpa 2015), (Ellram *et al.* 1989)
Data security & privacy	(Najaftorkaman *et al.* 2015), (Li *et al.* 2013), (Shrestha *et al.* 2016), (Gampala *et al.* 2012), (Chen and Zhao 2012), (Shariati *et al.* 2015), (Hamlen and Thuraisingham 2013), (Zhou *et al.* 2010), (Revathy *et al.* 2015), (Chen and Zhao 2012), (Rao *et al.* 2014), (Rezaeian *et al.* 2016), (Rong *et al.* 2013), (Lallmahamood 2015), (Thulani *et al.* 2015), (Alboaie *et al.* 2015), (Duquenoy *et al.* 2013), (Kalogridis and Dave 2014)(Sahama *et al.* 2013), (Sahi *et al.* 2016)

As such, the researchers reviewed a total of 74 articles that mentioned the importance of the proposed factors, in which the percentage of each factor's resources from the total number of articles is shown in Figure 1.

RESULTS

The interview questions guided the researchers to deduce the required information from the interviewees, the questions generally asked about the current situation of the state of the IT resources, specifically the use of cloud computing in health information systems being used. It can be found that the physicians more concern about two main factors, system compatibility and data security and privacy, while the show less care about the factors of Internet network and hardware modularity. From the technicians' perspectives, they show more care about the factors of Internet network, training and cost effectiveness. Furthermore, they showed less care about the factors of system complexity and compatibility.

On the other hand, the interviewees pose a negative perception about the effectiveness of current technologies in managing and maintaining a large volume of health records in a timely manner. They also acknowledged the lack of access to effective computing to help health professionals to perform multiple activities related to sharing and retrieving records. Based on that, we found that cost effectiveness, hardware modularity, software modularity, Internet network, training availability, system compatibility, system complexity, and data security and privacy determine the successful utilization of cloud computing services in the Iraqi public healthcare sector.

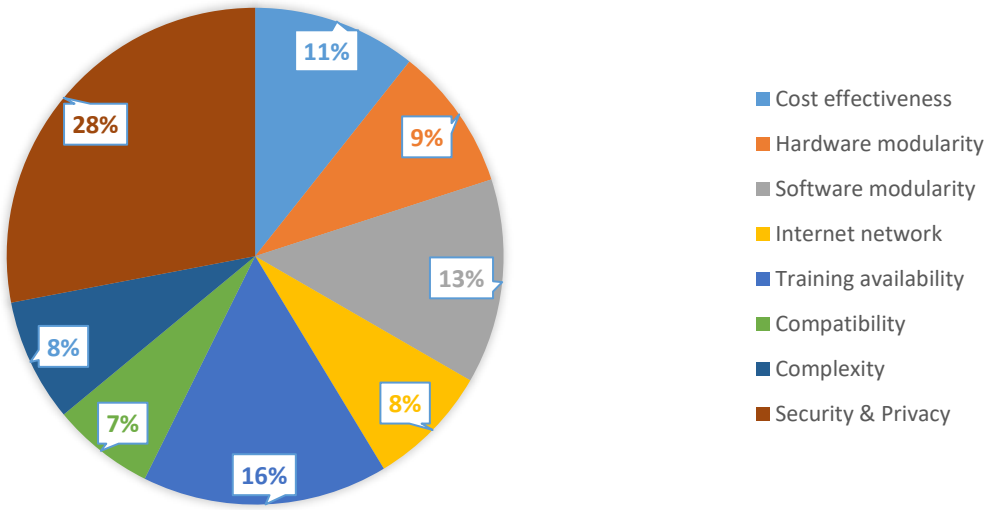

FIGURE 1. Factors' percentages

DISCUSSION

In this study, we defined the success factors that may affect the healthcare professionals' perceptions towards utilizing cloud computing services in the Iraqi healthcare sector, based on the results obtained from the preliminary study conducted using a semi-structured interview with 30 physicians and technicians from four hospitals in Iraq. The resulted factors were supported by the literature, in which the mentioned factors can be seen to be relevant to the context of this study. As a result using the combination of these factors in determining the Iraqi healthcare professionals' perceptions towards utilizing cloud computing services would increase the successful utilization of such services.

ACKNOWLEDGEMENTS

We gratefully acknowledge the fund received from the faculty of information science and technology, Universiti Kebangsaan Malaysia and DPP-2015-021 to support this research.

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Received: 28 July 2017
Accepted: 6 December 2017